Early Renaissance altarpieces in Transylvania: materials and technological characteristics

Cristina Serendan, David Hradil, Janka Hradilová and Joseph Cannataci

ABSTRACT This contribution focuses on the identification of the materials and technological characteristics of painting workshops active in Transylvania in the first decades of the sixteenth century. The first group of workshops considered was located in Sighişoara, one of which is known to have been run by Johannes Stoss. The altarpieces in the second group are attributed to the workshop of Vincentius, a painter in Sibiu, who signed and dated several altarpieces and one fresco painting still preserved in the region. Extensive research carried out during the past five years has brought to light important new evidence regarding particular features and similarities in the preparatory layers, gilding techniques and paint application. Complementary analytical methods and close visual examination were used to identify the structure and the composition of the grounds, poliments and precious metals on the painted panels. The results point to technological features common to the workshops, such as red poliments pigmented with iron oxides and cinnabar, and to complementary 'fingerprint' characteristics that can occasionally be corroborative, including gilding techniques associated with coloured glazes, red underdrawing and particular techniques of paint application.

Introduction

For more than 100 years, since altarpiece production in Transylvania came to the attention of art historians and other scholars interested in the development of arts and crafts in Saxon and Hungarian communities, considerable focus has been placed on the activity of Johann Stoss, one of the sons of the famous German sculptor Veit Stoss.[1] This pre-eminent artist, whose name has been associated with a major workshop in Sighişoara (Segesvár/Schäßburg), is traditionally considered to be the master and coordinator of work for a large group of altarpieces produced in the Saxon lands for the Catholic Church and still preserved in evangelical churches throughout Transylvania, Table 1. Although apparently born in Krakow, Poland, where his father Veit spent almost 20 years and established a major workshop while working on his masterpiece for the church of St Mary, the life and activity of Johann Stoss in Transylvania remains largely a mystery even today. The only documented information known to date is found in a letter from 1534 regarding the inheritance from his father.[2] The document suggests that by that time Johann Stoss was already dead, leaving behind a wife, three sons and a workshop, which was taken over by his assistant Christian. In the light of this scarce documentary evidence, the attribution of the altarpieces to his workshop is based mainly on stylistic grounds and structural similarities. Johann did not sign any of the surviving artworks (a common practice among the artists of those times), but in some cases the dates are mentioned on the frames or even on the panels of the altarpieces. In 2008 it was suggested that the woodwork itself forms part of the evidence that two or more autonomous but collaborating workshops existed in Sighişoara in the first quarter of the sixteenth century.[3]

Some recent research by the authors and colleagues has revealed evidence that strengthens this hypothesis for the existence of two or more autonomous but collaborating workshops.[4] Indeed, when grouping existing works by poliments, artistic techniques, joinery and other characteristics, a picture emerges of several painters operating cooperatively in Sighişoara, either in the same or separate workshops. They would not have been strictly focused on only one technique of painting, but would also have executed wall paintings, the decoration of objects, painted banners and so on. The wooden sculpture, gilding and joinery that together with the painting form the final altarpiece could often (but not necessarily always) have been the result of collaboration between workshops that operated individually and specialized in separate trades, or occasionally, to different degrees, have been accomplished 'in-house' within the artist's own workshop. The same joiner, sculptor or gilder could thus be involved in altarpieces or other works for commissions being undertaken by different master painters operating within the same town or county and vice versa. All the evidence suggests that, even if he had his own separate workshop, when a gilder (for example) was engaged for the work required by a commission, because of the size of the altarpiece and the work sequence followed – painting, gilding and painting again, often in quick succession – it is likely that he would have

Table 1. List of the altarpieces studied.

Altarpiece	Full name: origin, date[1]
Sighişoara Group of Workshops (SGOW)	
Băgaciu (Bogács/Bogeschdorf)	Altarpiece of Saints Mary, Catherine and Magdalena: evangelical church of Băgaciu, 1518
Beia (Homorodbéne/Meeburg)	Altarpiece of Saint Ursula: evangelical church of Beia, 1513
Bruiu (Brulya/Braller)	The altarpiece of Saint Nicholas: evangelical church of Bruiu, about 1515–1520
Cund (Kund/Reußdorf)	Altarpiece of Saint Nicholas: evangelical church in Cund, about 1520–1530
Fişer (Sövénység/Schweischer)	Saint Martin altarpiece: evangelical church of Fişer, 1520–1522
Roadeş (Rádos/Radeln)	Altarpiece of Saint John: evangelical church of Roadeş, about 1520–1525
Sighişoara (Segesvár/Schäßburg)	Altarpiece of Saint Martin: Dominican church of Sighişoara, about 1520–1525
Şoroştin (Sorostély/Schorsten)	Passion altarpiece: evangelical church of Şoroştin, about 1520
Vincentius workshop in Sibiu	
Jidvei (Zsidve/Seiden)	Unknown dedication: evangelical church of Jidvei, 1508
Vincentius workshop in Sibiu (attributed)	
Mediaş 2[2] (Medgyes/Mediasch)	The Last Supper predella: unknown origin, today part of the main altarpiece in the evangelical church in Mediaş, about 1525–1530

[1] Where a single date is given the painting is securely dated by original inscriptions on the panels or frames.

[2] In recent literature on the subject, the name Mediaş 2 is conventionally given to this predella, which today is in the niche that once housed the original predella of the high altarpiece of the evangelical church in Mediaş (conventionally named Mediaş 1).

developed a very close relationship with the master sculptor or painter, dropping into the latter's workshop regularly. This accumulation of evidence has prompted the authors to opt for a terminology that favours the use of the phrase 'the Sighişoara group of workshops' (SGOW) rather than the 'Johann Stoss workshop', on account of the growing probability that while the Stoss workshop certainly existed it did not act alone or was not the only workshop that attracted commissions. How many workshops there were, precisely where they were located, and who did what with whom remains to be determined, but that they housed several craftsmen who performed different roles on the same Transylvanian stage is a certainty. Some may have operated in the vicinity rather than actually within the walls of Sighişoara and arguments have also been put forward regarding the density of works found within the Sighişoara, Mediaş (Medgyes/Mediasch) and Biertan (Berethalom/Birthälm) triangle, but until more precise evidence is available, SGOW or the Sighişoara Group may be useful as a working title.[5]

While the evidence for several workshops implicit in the research cited above is compelling, the special background and abilities of Johann Stoss should also be recognized. It would not be impossible that a person such as Johann, raised in a workshop as illustrious as the one that had produced a monumental masterpiece such as the Veit Stoss altarpiece in Krakow, would have acquired the skills of both gilding and painting. In addition, Johann Stoss has been referred to as both a painter and a sculptor.[6] When taken together with the fact that he had two other brothers – Veit, a sculptor and Martin, a goldsmith, both working either in Sighişoara or within 100 km – Johann seems to have had both the personal skills and the connections to accept and deliver major commissions such as the altarpieces under study.

In 1523 the name of Veit Stoss, son and namesake of the more famous father (who by then was re-established in Nuremberg, to which he had returned in 1496), appears among the members in a guild statute from Braşov (Brassó/Kronstadt) where, for the first time, the painters, carpenters, sculptors and glass blowers were regulating their organization with their first statute within a guild.[7] It is known that he was a sculptor or woodcarver, as evident from his title 'Meister Bildschnitzer', which he signed as a member of the guild, but unfortunately the precise extent of his work remains unknown.

In contrast to the unsigned works currently attributed to the Johann Stoss workshop in Sighişoara, one of the few altarpieces for which the artists are known is that from Jidvei (Zsidve/Seiden), which is today in the church at Tătârlaua (Felsötatárlaka/Taterloch). Magistros Simonem sculptorem, together with his son-in-law, Vincencium picto rem Cibiniensem – Vincentius from Sibiu (Nagyszeben/Hermannstadt) – completed the construction of the altarpiece in 1508 and fortunately provided full evidence. There are another five works attributed to this workshop in the literature.[8] Vincentius seems to have been an unusual painter who signed his full name and dated his work, whether painted on panels or walls. As for the presumed Johann Stoss workshop in Sighişoara, very little is known about the life of Vincentius. Recent studies mention his possible training in Vienna at the beginning of the sixteenth century, where he would have become familiar with Lucas Cranach's early works and the so-called Danube school of painting.[9] By 1508, when he completed the altarpiece for the church in Jidvei, it is obvious that he found inspiration in Albrecht Dürer's engravings, which he used as models for his compositions in an almost identical form.[10] Small variations in style can be

Table 2. Summary of analytical results on grounds.

Altarpiece	Sample No. / from	Materials composition	Binder
Băgaciu	1 / gilding	calcium sulphate	N/A
	2 / gilding	calcium sulphate, quartz (as natural impurity)	proteinaceous
Beia	1 / gilding	calcium sulphate (mostly gypsum), quartz (as natural impurity)	animal glue
	2 / blue background on shrine	calcium sulphate (mostly gypsum)	animal glue
Bruiu	1 / gilding	calcium sulphate	proteinaceous
Cund	1 / gilding	calcium sulphate (mostly gypsum)	animal glue
Fişer	1 / gilding	calcium sulphate (gypsum, anhydrite)	proteinaceous
	2 / gilding	calcium sulphate with natural impurities (Al, Si, Fe, K)	N/A
Roadeş	1 / gilding	calcium sulphate (gypsum, anhydrite)	animal glue
	2 / blue on silver (sculpture)	calcium sulphate (gypsum, anhydrite)	animal glue
	3 / gilded brocade (sculpture)	calcium sulphate (gypsum, anhydrite)	animal glue
Sighişoara	no sample (XRF data only)	calcium sulphate	N/A
Şoroştin	1 / gilding	calcium sulphate (gypsum, anhydrite)	animal glue
	2 / silvering on frame	calcium sulphate (gypsum, anhydrite)	animal glue
Jidvei	1 / gilding	calcium sulphate (anhydrite, gypsum), quartz, earth pigments (Al, Si)	N/A
Mediaş 2	1 / painted brocade	calcium sulphate (gypsum, anhydrite)	proteinaceous

noted between his first signed work for Jidvei in 1508 and the last painting that survives, produced in 1525, but the inspiration of Dürer remains constant. This seems to have been common practice among painters in Transylvania in the first half of the sixteenth century.

The workshop run by Vincentius from Sibiu was chosen as a comparison because of its clear attribution and origin, and because it is contemporary with the activity of the workshops in Sighişoara and was situated in their geographic vicinity, less than 100 km away.

Methods

Extensive research carried out by a multidisciplinary team over the past five years has brought to light important new findings regarding the materials and painting technologies.[11] Since all these altarpieces are still preserved in churches, the research was focused primarily on visual examination of the paintings and on non-invasive measurements by portable X-ray fluorescence (XRF). Some limitations had to be taken into consideration: the onsite conditions for examination, the difficult access to the upper parts of the paintings due to their size and display on the altar table, and the limited sampling that was possible. The portable XRF equipment allowed extensive and non-invasive screening of the elemental composition of the paint layers. Two different instruments were used in order to compare results from point measurements in the same areas (see the technical appendix). One very important feature of this relatively easy-to-use equipment was the possibility of identifying metal foils beneath paint, especially useful in the case of the altarpieces attributed to the SGOW. Samples were analysed by light microscopy, scanning electron microscopy with energy dispersive X-ray spectrometry (SEM-EDX), powder X-ray micro-diffraction (micro-XRD) and micro-Fourier transform infrared (micro-FTIR) spectroscopy; microchemical tests were also carried out on cross-sections (see the technical appendix).

Materials and technological characteristics common to several workshops

Grounds

As shown in the Introduction, due to the close stylistic similarities with the schools of painting in central Europe, especially those from centres such as Vienna and Nuremberg, it appears that it had previously been assumed that the altarpieces preserved in Transylvania also share the same techniques and materials as their Austrian and German counterparts. This is perhaps why in the publication by the Richters the very sparse material and technological data provided presents the composition of the grounds as calcium carbonate (typical for the grounds of German paintings to which they have such close stylistic affinities).[12] In other studies, however, the grounds or gilded reliefs are referred to as gessoes or stuccoes, with no analytical data to accompany these statements.[13] More probably the terms are used in a general way and as the term traditionally applied to all the grounds or *bas-reliefs* on panels.

The analytical investigations of the altarpieces in this study provided an interesting result: for both workshops, the grounds of the altarpieces contain calcium sulphate (gesso) and not the expected calcium carbonate (chalk) characteristic of the northern European and Germanic schools of painting. The technique of preparation is typical for the period: after first sealing the wood, the gesso is bound with animal glue and applied in several coats so that eventually it forms one layer of white ground with a thickness ranging from 200 μm to 1 mm. The different origins of the gesso can be noted from the variations in the grades of purity, Table 2. Clay minerals and quartz grains have been identified in some of the samples either as impurities related to the fabrication process or as intentionally added earth pigments used to colour the ground, as in the case of the Jidvei altarpiece.

In the context of Transylvanian altarpieces this result shows continuity in the choice of gesso as the main ingredient of the grounds. Earlier research on Transylvanian altarpieces dated from both the fifteenth and sixteenth centuries showed that

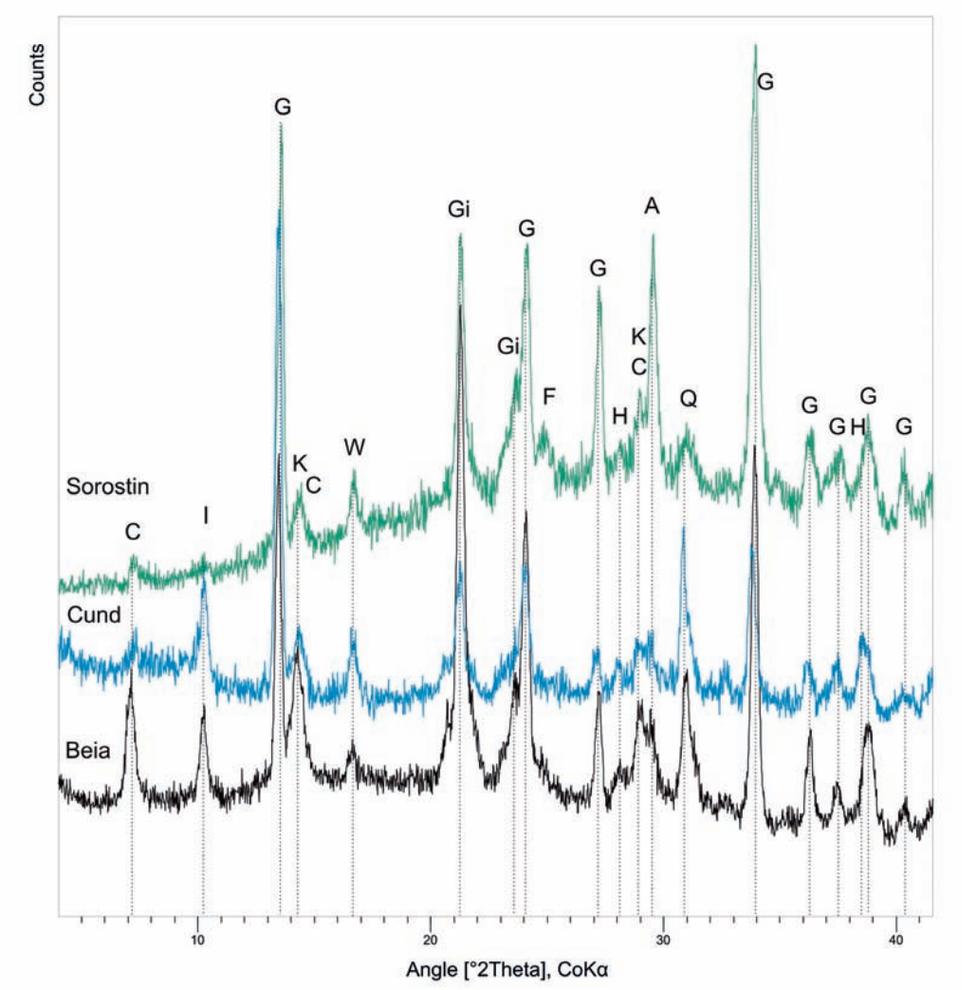

Figure 1. Similarities in mineralogical composition of gilding poliments from the Beia, Cund and Şoroştin altarpieces, as measured by micro-XRD on the top of the fragments. **G**: gypsum ($CaSO_4 \cdot 2H_2O$); **Gi**: gibbsite ($Al(OH)_3$); **C**: chlorite group mineral ($(Fe,Mg,Al)_6(Si,Al)_4O_{10}(OH)_8$); **K**: kaolinite ($Al_2Si_2O_5(OH)_8$); **I**: Fe-low clay mica (illite) ($K_{0.7}Al_2(Si,Al)_4O_{10}(OH)_2$); **A**: anatase ($TiO_2$); **W**: weddelite ($C_2H_4CaO_6$); **F**: goethite (α-FeO(OH)); **H**: hematite (Fe_2O_3); **Q**: quartz (SiO_2). The gypsum comes from the white gesso ground and weddelite (calcium oxalate) is a secondary phase contaminating the surface.

Table 3. Summary of analytical results on poliments.

Altarpiece	Elemental composition[1]	Mineralogical composition[2]	Binder[3]	Metal leaf
Băgaciu	**Al**>Si, Fe, K, Ca, Ti, **Hg**	N/A	N/A	gold
Beia	**Al**>Si, Fe, K, Ca, Ti	mixture of Al, Fe (hydro)oxides (hematite, gibbsite, goethite) and Ti oxides (anatase), clay minerals (chlorite, kaolinite, clay mica) and quartz	proteinaceous	gold
Cund	**Al**>Si, Fe, K, Ca, Ti	mixture of Al, Fe (hydro)oxides (hematite, gibbsite, goethite) and Ti oxides (anatase), clay minerals (chlorite, kaolinite, clay mica) and quartz	proteinaceous	gold
Fişer	Si>Al, Fe, K, Ca, Ti, **Hg**	low Mg earthy pigments with predominant kaolinite, quartz	proteinaceous	gold
Roadeş	**Fe**, Si>Al, K, Ca, Ti	Fe-rich poliment containing Fe (hydro)oxides (lepidocrocite, goethite and hematite), clay minerals (Fe-chlorite, kaolinite, clay mica-illite), other silicates (hornblende), quartz and Ti minerals (anatase)	proteinaceous	gold
Şoroştin	**Al**>Si, Fe, K, Ca, Ti	mixture of Al and Fe (hydro)oxides (gibbsite, hematite, goethite), clay minerals (chlorite, kaolinite, clay mica-illite), and quartz	proteinaceous	gold
	Al>Si, Fe, K, Ca, Ti	N/A	N/A	silver
Jidvei	Si>Al, Fe, K, Ca, **Hg**	low Mg earthy pigments with predominant kaolinite, quartz and hematite	N/A	gold
Mediaş 2	**Al**>Si, Fe, K, Ca, Ti	mixture of Al and Fe (hydro)oxides (gibbsite, hematite, akaganeite), clay minerals (kaolinite, clay mica-illite, and expandable clay minerals) and quartz	N/A	gold

[1] Combination of results obtained by non-invasive XRF and SEM-EDX (all the elements may not be contained in all measurements); probable intentional additives are indicated by increased concentrations of elements (in bold): Al = bauxite or red lake, Fe = hematite, Hg = cinnabar.

[2] Results obtained by micro-XRD; mineral phases present in low concentrations only could not be detected (e.g. cinnabar).

[3] Results obtained by histochemical tests and micro-FTIR analysis.

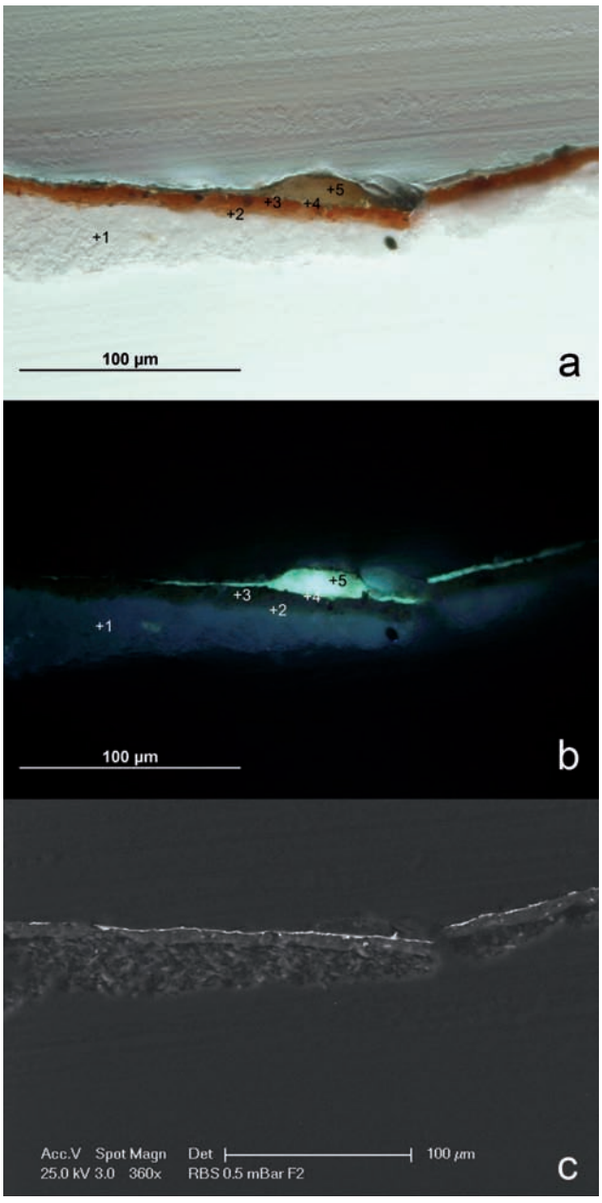

Figure 2. Cross-section of a sample from the Fişer altarpiece in: (a) visible light; (b) UV luminescence; and (c) the backscattered electron SEM image. The layers are: (+1) pure gesso ground; (+2) isolation layer; (+3) thick layer of red poliment containing earth pigments with kaolinite, quartz and potassium-containing phases (e.g. mica), additionally pigmented by cinnabar – apparent as small light grains in the SEM image; (+4) gold leaf; and (+5), secondary varnish containing calcium carbonate, probably lead white, ochres and surface impurities.

the majority have gesso grounds rather than calcium carbonate grounds. Out of 15 altarpieces studied by the authors, three were found to have grounds composed of two or even three layers (with the layers having different compositions) and the rest are simple grounds of pure gesso.[14] Although the literature suggests that gesso grounds are rare in central Europe,[15] in Transylvania, even in the Saxon communities, the data found so far seem to indicate that there they represent general practice.

In spite of their stylistic affinities with central and northern European works, the composition of the grounds seems to place them closer to the Mediterranean tradition. It is still uncertain whether the preference for gesso derives from a Byzantine tradition quite prevalent in the region, or to greater local availability of the material, so that the choice of materials was directly linked to the cost and the ease with which they could be obtained.

Poliments and gilding

One of the focuses of this research was the application of precious metals in the form of metal leaf or powder. These materials can be good indicators of workshop practice and also of the distribution of work for the production of altarpieces, if they are considered as a larger collaborative enterprise. Indeed, one of the future directions for this research will be the question of precisely how the labour was divided within a workshop or even possibly between separate workshops (e.g. painting, woodwork, sculpture and gilding).

Among the features of painting technique in the SGOW is the extensive use of applied metal leaf and elaborate decorative techniques, especially on the feast-day side (the inner decorated panels revealed on special occasions). The altarpieces have a similar construction with a central shrine, one pair of fixed side panels, one pair of wings and a predella. Usually, the metal leaf decoration is on the feast-day side of the altarpieces, while the outer side (the work-day side) is more sober.

The feast-day side is richly embellished with gilded decoration, including the characteristic gilded arches that frame the compositions and the backgrounds. Whether carved or engraved into the ground, these arches are gilded with high quality gold leaf and burnished. Other large areas using the same gilding technique are the backgrounds of the shrines, always embellished with brocade patterns engraved into the ground. From the SGOW there are only two altarpieces, that in Băgaciu (Bogács/Bogeschdorf) and that in Roadeş (Rádos/Radeln), where gilded arches are present on the outer side of the panels as well, presenting almost no difference in appearance between the feast-day side and the work-day side.

It is the burnished gilding in particular that links the altarpieces attributed to the SGOW, Table 3. Burnished gilding is usually applied on a coloured ground called a 'poliment', which generally consists of a mixture of red clay (called bole) and a proteinaceous binder (animal glue or glair) as the main components. True boles should contain predominantly fine-grained clay minerals (quartz and other coarse-grained minerals are generally much less abundant) and also, being a product typical of alkaline rock weathering, the titanium content is usually greater than the potassium content (i.e. potassium-containing phases such as micas or feldspars are almost absent, while the content of anatase is relatively high).[16] The interesting composition of the poliments identified in the burnished gilding groups together the altarpieces from Cund (Kund/Reußdorf), Roadeş, Şoroştin (Sorostély/Schorsten) and Beia (Homorodbéne/Meeburg), Figure 1. Their poliments do not contain boles as described above, but lower quality earths, with clay minerals (kaolinite) and some anatase in addition, as well as a large amount of potassium-containing micas,

Figure 3. Identification of metal leaf on the Saint Martin altarpiece from Sighişoara by portable XRF measurement: Au = gold leaf, Ag = silver leaf and AuAg = *zwischgold*.

chlorites and quartz. The original colour and technological properties of this alternative material probably varied and the reason for the addition of other pigments may have been to improve its quality.

In the Roadeş altarpiece extra hematite was probably added, as indicated by an increased iron concentration and clearly visible hematite grains. From previous studies on boles it is known that hematite grains are not necessarily associated with the natural composition of the clay, but could have been added intentionally to the earthy material.[17] In the Cund, Beia and also Mediaş 2 (Medgyes/Mediasch) and Şoroştin altarpieces substantially higher contents of hematite (Fe_2O_3) and gibbsite ($Al(OH)_3$) were found. The latter is the most interesting feature, since it indicates the possible addition of bauxite – a rusty or red rock containing both iron and aluminium oxides. Bauxite could have come from the deposits exploited in Romania, Hungary or southern Europe. Another explanation could be that gibbsite represents the substrate of a red lake (which it has not yet been possible to confirm is present in the mixture). In either case, the presence of gibbsite is a clear indication of the addition of a pigment (either a lake or bauxite) to intensify the hue or colour, and therefore an interesting workshop practice for early Renaissance painting in Transylvania. In Şoroştin, for example, the same gibbsite-containing poliment was used for both gilding and silvering. The presence of gibbsite is further indicated by substantially increased concentrations of aluminium in poliments on the Băgaciu altarpiece, although mineralogical data are not available.

An even more surprising additive was identified on altarpieces from Fişer (Sövénység, Schweischer), Jidvei and Băgaciu. Here the extra colouring of the natural earth is very evidently achieved through the addition of a relatively large amount of cinnabar, Figure 2. Cinnabar was first identified by the on-site measurements with XRF and confirmed later by SEM-EDX on samples. The discovery is even more important because of the distinct origin of the three altarpieces: the use of a similar technology for the gilding by at least two different workshops gives a broader impression of what would appear to be a fairly widespread workshop practice in Transylvania in the first half of the sixteenth century.

Translucent painting as a technological feature of the Sighişoara group of workshops

While burnished gilding on a red poliment was used in both the Vincentius workshop and SGOW for the decoration of frames, backgrounds, gilded arches and haloes on both the feast-day side of the altarpiece and on the polychrome sculpture, mordant gilding served as the preferred method for application of metal foils on the rest of the panels.

All kinds of metal objects and accessories, such as the buttons on garments, mitres, sceptres, small or large pots, were executed with *zwischgold* or even pure gold applied on an oil-based mordant containing a mixture of various pigments. *Zwischgold* (German), also called part-gold, *oro di metà* (Italian) and *or parti* (French) is a metal leaf formed by beating together a layer of gold and a thicker layer of silver. The result is a metal leaf similar in appearance and thickness to gold leaf. The manufacture of this type of leaf is described in the treatise of Theophilus (Book III, chapter 77) and was widely used in Medieval panel painting as a cheaper alternative to pure gold leaf.[18] Metal objects such as the soldier's armour, swords or halberds follow the already traditional method of representation with silver leaf. The attention to detail and the

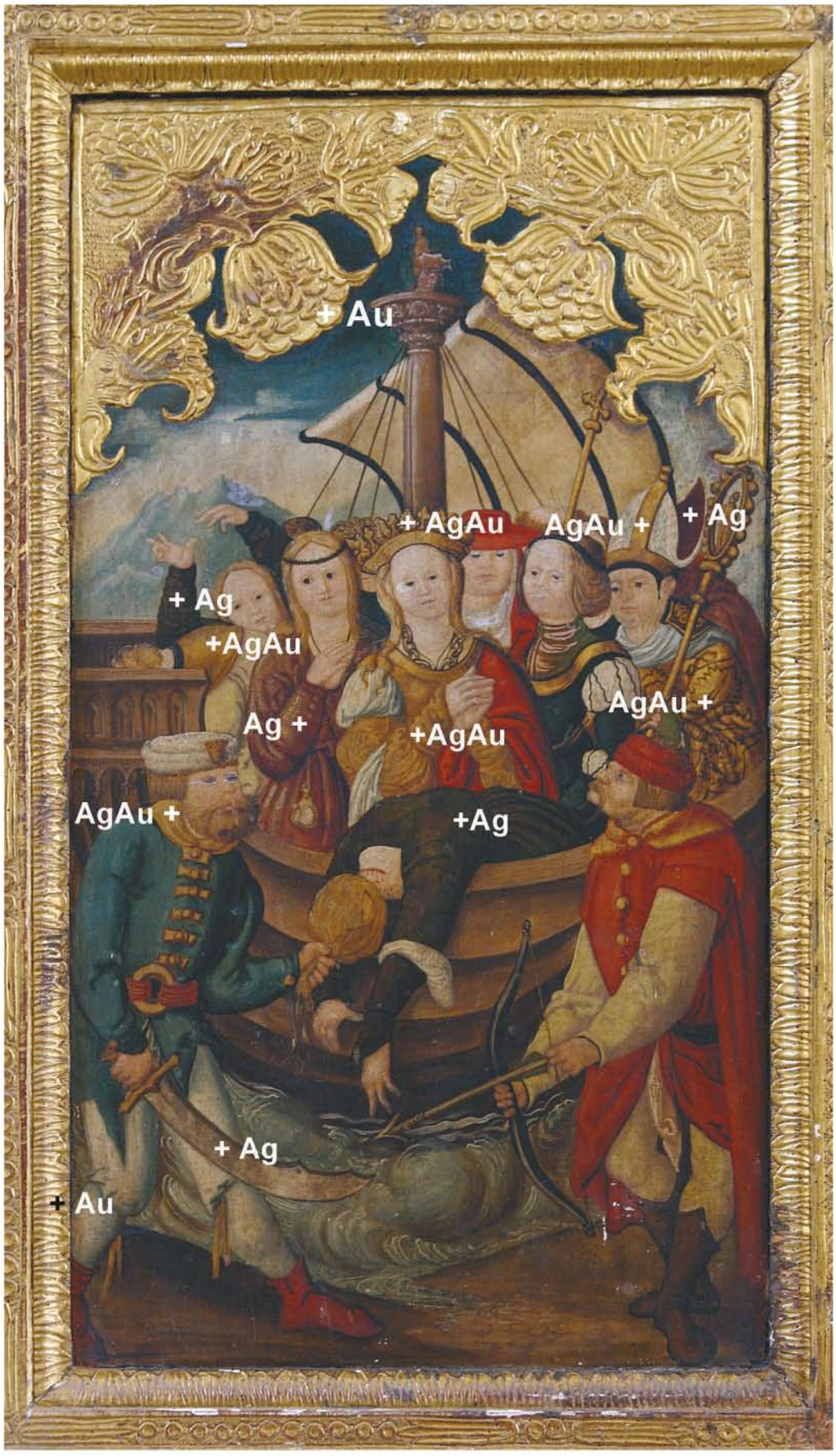

Figure 4. Identification of metal leaf on the panel depicting the martyrdom of Saint Ursula from the altarpiece from Beia by portable XRF measurement: Au = gold leaf, Ag = silver leaf and AuAg = *zwischgold*.

extensive use of gilding and metal leaf on the paintings is one of the features of the painting techniques on the altarpieces attributed to the SGOW.

Apart from the decorations in which the metal leaf is visible, one other technological preference can be considered a feature of the SGOW: the use of coloured glazes over large areas of gilding and silvering. This is the so-called translucent painting (*pittura translucida* or *aureola*), first mentioned by Theophilus in Book 1, chapter 27.[19] Measurements by portable XRF made possible the identification of the type of metal lying under thin or sometimes very thick and opaque layers of paint. Analysing the altarpieces from the SGOW, a technological pattern in the use of translucent painting could be identified: silver is the metal preferred as a base where the metal leaf is completely covered with translucent paint, while *zwischgold* was used mainly for the imitation of golden brocades and other luxurious textiles and accessories, Figures 3 and 4. *Zwischgold* was always used for the visible gilding, with the clear purpose of achieving a similar effect to gold leaf but more inexpensively. From the findings of this study, it would appear that *zwischgold* was always applied as matt gilding and never as burnished gilding. Examination of the gilded surface, with its characteristic micro-fissured structure and a matt appearance, indicates the use of oil-based gilding. Not all the altarpieces attributed to the SGOW made such extensive use of translucent painting. Slight variations can be noticed even over a relatively short space of time. A strong similarity can be seen between the altarpieces for Beia, Cund and Sighişoara. The altarpiece in Băgaciu, for example, finished in 1518 and thus only five years after that in Beia, still has the rich golden brocade garments that can be seen on the earlier work, but it does not use the translucent glazing on silvering to achieve subtle effects in red, green or violet textiles, possibly an indication of a different hand within the collaborating workshops. On the other hand, in the altarpieces at Fişer and Roadeş, dated around two and five years later, the painter reverted to the abundance of coloured glazes.

Such artistic effects were used in Transylvania even before the sixteenth century, as a background for the imitation of brocade textiles. The technological difference is that in earlier works part of the gilding was always visible in one form or another (textured by small incisions, punches or with regular strokes of paint, or simply only partially covered by the painted design). From the sixteenth century onwards the aesthetic design and appearance of the altarpieces changed: the gilded backgrounds on the panels were slowly

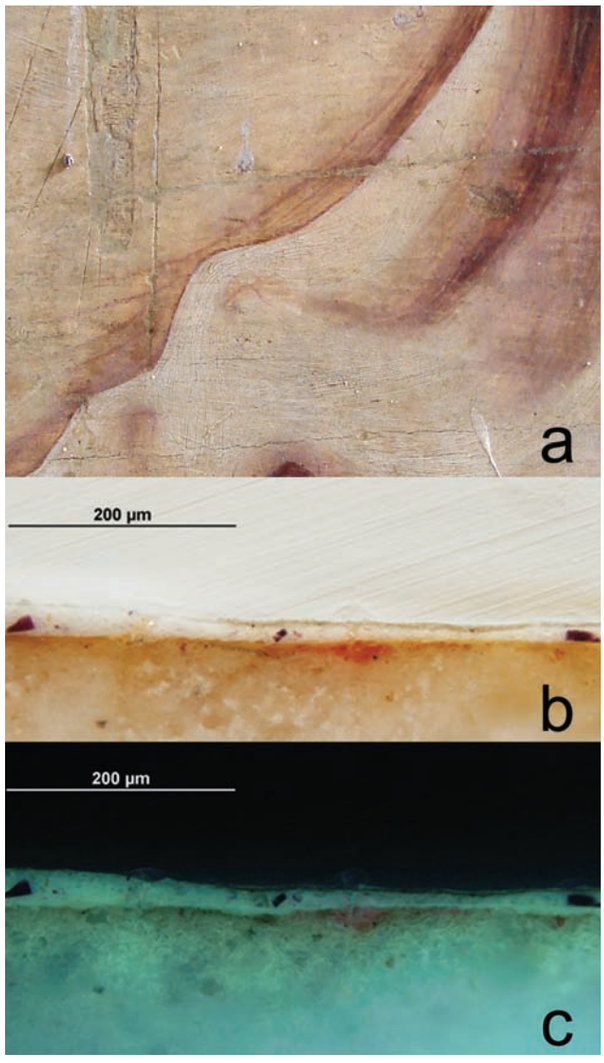

Figure 5. Red underdrawing visible beneath the paint on the Fişer altarpiece: (a) visible image of the surface; (b) in a cross-section viewed under visible light; and (c) in the same cross-section viewed under UV light.

Figure 6. Vincentius's technological features on the altarpiece from Fişer: (left) the final drawing traced into the fresh paint; and (centre and right) green shading in the skin tones applied during the final stages in the execution of the painting.

replaced by landscapes and the composition was framed by the gilded arches. However, the extent of the use of precious metals did not necessarily decrease. As could be seen on the altarpieces attributed to the workshops in Sighișoara, the application of metal leaf had a new purpose – as a reflective surface to afford the colours greater brightness and intensity and to obtain subtle artistic effects in the representation of textiles.

The technological characteristics of paintings from the Vincentius workshop

In contrast to the workshops in Sighișoara, on the Jidvei altarpiece Vincentius made very little use of gilding within the painting and even less of translucent painting. In the examinations only burnished gilding was identified, with gold leaf on the frames and on the beautifully decorated gilded arches. Mordant gilding was used for application of metal foils on the painted surface to create very fine and discreet haloes, or for the gilding of crowns and mitres.

Other features make his painting technique unique in Transylvania. The underdrawing, generally executed with a brush and black paint (carbon black) on altarpieces from Transylvania, is instead executed in red. Close examination of the painting revealed broad underdrawing lines made with great dexterity, rather sketchy for the figures and more detailed for the garments and folds of the textiles. The red underdrawing was further confirmed by laboratory analysis of cross-sections, Figure 5. It is most probably executed with a dry material, and over it is an overall isolation layer with a proteinaceous binder that fixed the drawing before painting began. In Transylvania red underdrawing is very rare and the altarpiece in Jidvei (1508) is the earliest example among those that have survived. The same red underdrawing could be observed on another predella attributed to the same workshop, currently in the collection of Brukenthal National Museum in Sibiu. The predella is dated 1525 (according to its inscription) and comes from the former altarpiece from Cisnădie.[21] Although the painting is of lesser quality, some of the characteristics of Vincentius's painting identified on the Jidvei altarpiece are visible, including the red underdrawing. Considering the relatively long period of time that elapsed between the production of the two altars and their execution by the same workshop, the presence of red underdrawing in a similar manner as in the Jidvei work leads to the conclusion that it can be considered to be a possible technological feature of the artist.

Another interesting feature of the painting technique of Vincentius is that lines have been made by indenting into the wet paint to indicate some features of the composition, Figure 6. These have such freedom of execution that one can only imagine the joy the artist must have experienced while, with the handle of the brush or the palette knife, he drew decorative or even anatomical elements. In this way he created subtle decorative effects in an interesting and very rapid way, showing considerable dexterity based on extensive practice. It can be assumed that by the time he made the altarpiece for Jidvei in 1508 he had experience of various forms of artistic expression and was already a mature painter. His dexterity and versatility in painting technique may possibly also have resulted from his dual experience in panel and wall painting. As already mentioned, in the discussion on grounds, the preparation on the panels from Jidvei contains, apart from calcium sulphate, a clear admixture of quartz and earth pigments. This rare characteristic of a ground, which it would be expected would need to be very smooth to receive the paint layers, could also have been carried over from his practical experience in wall paintings.

The third characteristic of the painting technique of Vincentius that is worth emphasizing here is his particular manner of execution of areas of flesh. He started with a thin base colour, light ochre to brown, on which he built up the skin tones and highlights with spontaneous strokes of pasty paint. The shadows are especially distinctive, as Vincentius had a particular preference for greenish shades (obtained using copper-based pigments), which he applied at a final stage in the execution of the figures, Figure 6. He did not eliminate completely the brownish shades applied at an earlier stage of painting, but the green is dominant. His figures are a distinctive blend of greenish shades with vivid brown drawing and undertones. The greenish shades in the skin tones are atypical of Transylvanian altarpieces and can be considered as another signature of Vincentius's painting technique.

Conclusions

Those features found to be common to both the Vincentius and the Sighișoara workshops reveal interesting local characteristics in the use of materials and techniques in altarpiece production in Transylvania. Although their painting style is close to the Danube school and to central European painting, Italian influences can be noted in the preparation of the panels and the composition of the poliments used for the gilding.

The poliments are an interesting feature encountered on the altarpieces from both the Vincentius workshop and the SGOW, and they provide evidence of a technique formerly known from historic documentary sources on painting technique. All the findings indicate a clear preference for a thick and vivid red poliment obtained by the addition of red pigments to an earthy material. The data collected to date are still insufficient to provide a wider context for this practice, but the fact that the same recipe was found on altarpieces attributed to at least two different workshops may indicate either a regional characteristic or a technical connection between the two workshops. The presence of cinnabar discovered on altarpieces produced at considerably different times (10 and 12 years apart, as documented by original inscriptions) indicates that this practice was neither accidental nor isolated.

The extensive use of precious metals and translucent painting identified on altarpieces attributed to the SGOW reveals an elaborate painting technique, requiring good knowledge of the two crafts: gilding and painting. Over the years this remained one of the SGOW's technological features.

Even though the workshop of Vincentius and the SGOW share common practice with respect to the grounds and poliments, three distinct technological features could be identified on Vincentius's altarpiece from Jidvei: the use of red underdrawing in a dry medium; spontaneous and expressive lines made in the fresh wet paint, perhaps with the handle of a brush, with which the master produced subtle decoration and highlighted forms; and the preference for greenish shading applied in the final stages of the execution of areas of flesh. Some of these technical elements were also identified on other paintings attributed to the same workshop. Considered in the wider context of Transylvanian altarpieces, these features can be considered technological characteristics of Vincentius's painting technique and may contribute to a clear attribution of other works to his workshop.

Technical appendix

The XRF measurements were carried out with an Oxford Instruments X-MET 3000TXR (Rhodium anode, 40 kV) and an INNOV-X α Series (tungsten anode, 35 kV, 40 μA). Light microscopy was carried out on an OLYMPUS BX-60 optical microscope (visible and ultraviolet light), and documented with an Olympus DP 70 digital camera or with a Leica DMLS optical microscope (visible light). SEM-EDX was carried out on a Philips XL30 CP SEM at a working voltage of 25 kV and an EDAX EDX detector or on a Cambridge Stereoscan 360 SEM with an INCA Energy EDX System (Oxford Instruments). Micro-FTIR analysis was generally used for the analysis of the binder in the preparation layers and gilding adhesives. Infrared spectra were collected on cross-sections in reflection mode, using a Continuum infrared microscope with a Nexus microspectrometer (Thermo Nicolet, USA). The spectra were recorded in the region 4000–650 cm^{-1} with a resolution of 4 cm^{-1} and were analysed using Omnic 7.2 software (Thermo Electron Co.). Micro-XRD measurements were carried out on an X'PertPro (PANalytical) X-ray diffractometer with Co Kα radiation, a monocapillary focusing the primary beam to 0.15 mm diameter, and an X'Celerator multichannel detector.

Acknowledgements

This research was made possible with the kind permission of the Evangelical Church District A.B. in Sibiu and of each parish in which the altarpieces were examined. The authors express their gratitude to all their colleagues who performed analytical measurements: Petr Bezdička and Silvie Švarcová from the Institute of Inorganic Chemistry of the AS CR, v.v.i., ALMA laboratory, Czech Republic; Georghe Niculescu from the National Museum of Romanian History in Bucharest, Romania; Rosario Alaimo, Renato Giarrusso and Mauro Tantillo from CEPA Srl., Palermo, Italy; and the Polymer Institute in Brno, Czech Republic. Financial support from the Ministry of Culture of the Czech Republic (project No. DF12P01OVV048) and the MATERIALS project, University of Groningen, is kindly acknowledged.

Notes and references

1. The German-speaking communities who migrated to Transylvania in waves from the twelfth century onwards, from various parts of what is now Luxembourg and modern Germany, are commonly referred to as Saxons in Romania.
2. Lossnitzer, M., *Veit Stoss. Die Herkunft seiner Kunst, seine Werke und sein Leben*, Julius Zeitler, Leipzig (1912) 161–162.
3. Sarkadi, E., *Produced for Transylvania – local workshops and foreign connections: studies of late Medieval altarpieces in Transylvania*, PhD dissertation, Central European University, Budapest, Hungary (2008) 151.
4. Serendan, C., *Tehnici de poleire* în *pictura medievală pe panou din Transilvania* (*Gilding techniques in Medieval panel painting from Transylvania*), PhD dissertation, National University of Arts, Bucharest, Romania (2010).
5. Sarkadi 2008, cited in note 3, 149.
6. Lossnitzer 1912, cited in note 2, 211, note 477.
7. Nussbächer, G. and Marin, E. (ed.), *Quellen zur Geschichte der Stadt Kronstadt. Neuter Band: Zunfturkunden 1420–1580*, Aldus, Braşov (1998) 139–141 (original text with translation into Romanian).
8. The altarpiece from Moşna (Muzsna/Meschen), dated 1521, later purchased by the community of Cincu (Nagysink/Groß-Schenk), where today it is part of the main altarpiece of their evangelical church; two panels originally from the former altarpiece from Cisnădie dated 1525 (the predella and lunette); one predella of unknown origin representing Christ appearing to his mother after his resurrection, currently in the collection of Brukenthal Museum in Sibiu; the predella representing the Last Supper, again of unknown origin, today mounted in the high altarpiece of the evangelical church of St Margaret in Mediaş; and the wall paintings of the evangelical church in Ocna Sibiului (Vizakna/Salzburg) signed and dated 1522. See Sarkadi 2008, cited in note 3; Sarkadi Nagy, E., 'The place of the former altar from Cisnădie in the oeuvre of Master Vincencius', in *Convergences: European landmarks in Transylvanian arts*, ed. D. Dâmboiu and I. Mesea, ALTIP, Alba Iulia (2007) 33–42; Firea, C., *Arta polipticelor medievale din Transilvania (1450–1550) (Medieval altarpieces from Transylvania)*, PhD dissertation, Babeş-Bolyai University, Cluj-Napoca (2010).
9. Sarkadi Nagy 2007, cited in note 8.
10. Firea 2010, cited in note 8.
11. Serendan 2010, cited in note 4.
12. Richter, G. and Richter, O., *Siebenbürgische Flügelaltäre*, Wort und Welt Verlag, Thaur bei Innsbruck (1992).
13. Guy Marica, V., 'Altarul de la Jimbor' ('The altarpiece from Jimbor'), in *Studii şi cercetări de istoria artei* 18 (2) (1971) 203–222; Roth, V., *Siebenbürgische Altäre*, Strasbourg (1916).
14. Serendan, C., Hradilova, J. and Hradil, D., *Integrated approach for the identification and characterisation of painting grounds in Medieval altarpieces from Transylvania*, poster presented at MATCONS Conference, Craiova (2011).
15. Van Hout, N., 'Meaning and development of the ground layer in seventeenth century painting', in *Looking through paintings: the study of painting techniques and materials in support of art historical research*, ed. E. Hermens, Archetype Publications, London (1998) 199–225; Nadolny, J., 'European documentary sources before c. 1550 relating to painting grounds applied to wooden supports: translation and terminology', in *Preparation for painting: the artist's choice and its consequence*, ed. J. Townsend, T. Doherty, G. Heydenreich and J. Ridge, Archetype Publications, London (2008) 1–13.
16. Hradil, D., Hradilová, J. and Bezdička, P., 'New criteria for classification of and differentiation between clay and iron oxide pigments of various origins', in *Acta Artis Academica 2010 – proceedings of the 3rd interdisciplinary conference of ALMA*, ed.

D. Hradil and J. Hradilova, Academy of Fine Arts, Prague (2010) 107–136.

17. Nadolny, J.M., *The techniques and use of gilded relief decoration by northern European painters, c. 1200–1500*, PhD dissertation, vol. I, University of London, London (2000) 159.
18. Nadolny 2000, cited in note 17; Theophilus, *On diverse arts*, 2nd edn, trans. J.G. Hawthorne and C.S. Smith, Dover Publications, New York (1979).
19. Theophilus 1979, cited in note 18.
20. Vlaicu, M. (ed.), 'The statute of painters, carpenters and glass blowers from Sibiu', in *Quellen zur Geschichte der Stadt Hermannstadt (1224–1579)*, Hora, Sibiu (2003) 264–269 (original text with translation in Romanian).
21. Its attribution to the Vincentius workshop was recently reconsidered with new arguments put forward: the stylistic characteristics and the identification of a possible unique characteristic of the Vincentius workshop. See Sarkady Nagy 2007, cited in note 8.

Authors

- *Corresponding author*: Cristina Serendan, Department of Conservation and Restoration, National University of Arts, Bucharest, 19 Budisteanu Street, sector 1, Bucharest, Romania (cserendan@yahoo.com).
- David Hradil, Institute of Inorganic Chemistry of the AS CR, v.v.i., ALMA laboratory, 250 68 Husinec-Řež, Czech Republic; and Academy of Fine Arts in Prague, ALMA laboratory, U Akademie 4, 170 22 Prague 7, Czech Republic.
- Janka Hradilová, Academy of Fine Arts in Prague, ALMA laboratory, U Akademie 4, 170 22 Prague 7, Czech Republic.
- Joseph Cannataci, Faculty of Law, University of Groningen, The Netherlands and Faculty of Media & Knowledge Sciences, University of Malta.